Question Paper Code : 11181

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Third Semester

Civil Engineering

CE 2202/101302/CE 35/CE 1203/10111 CE 305/080100015 — MECHANICS OF FLUIDS

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Differentiate between specific weight and specific gravity of an oil.
2. Define compressibility and surface tension.
3. Define total pressure on a surface and centre of pressure of a surface.
4. Briefly explain the terms centre of buoyancy and metacentre.
5. Sketch a pitot tube and explain briefly how it is used to measure the velocity of a flowing liquid.
6. Two horizontal plates are placed 15 mm apart, the space between them being filled with oil of viscosity 15 poise. Calculate the shear stress in the oil, if the upper plate is moved with a velocity of 3.0 m/sec.
7. Define the terms Displacement thickness and Momentum thickness.
8. What are the major and minor energy losses in a pipe line?
9. Define the term Dimensional Homogeneity. How is it attained in a fluid equation.
10. Define the terms Geometric Similarity and Kinematic Similarity.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Calculate the capillary rise in millimetres in a glass tube of 4 mm diameter. When immersed in

(1) water and (2) mercury.

The temperature of the liquid is 20°C and the values of surface tension of water and mercury at 20°C in contact with air are 0.0735 N/m and 0.51 N/m respectively. The contact angle for water $\theta = 0^\circ$ and for mercury $\theta = 130^\circ$. Take specific weight of water at 20°C as equal to 9790 N/m^3. (8)

(ii) A plate having an area of $0.6m^2$ is sliding down the inclined plane at 30° to the horizontal with a velocity of 0.36 m/sec. There is a cushion of fluid 1.8 mm thick between the plane and the plate. Find the viscosity of the fluid if the weight of the plate is 280 N. (8)

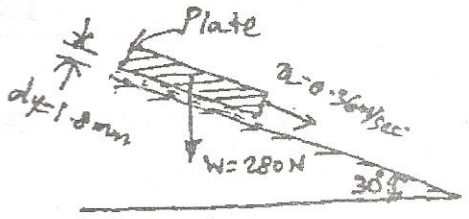

Fig.1

Or

(b) (i) What are the units of mass density, specific weight, dynamic viscosity and kinematic viscosity in S.I units. (4)

(ii) A 400 mm diameter shaft is rotating at 200 r.p.m in a bearing of length 120 mm. If the thickness of oil film is 1.5 mm and the dynamic viscosity of the oil is 0.7 N.S/m² determine the torque required to overcome friction in bearing and power utilised in overcoming viscous resistance. Assume a linear velocity profile. (12)

12. (a) (i) A U-tube containing mercury is used to measure the pressure of an oil of specific gravity 0.8 as in Fig. 2. Calculate the pressure of the oil, if the difference of mercury level be 500 mm. (8)

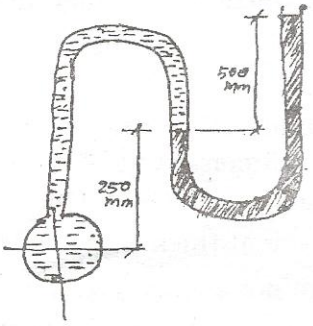

Fig. 2

(ii) A square plate ABCD $5m \times 5m$ hangs in water from one of its corner as shown in Fig. 3. Determine the total pressure and the position of the centre of pressure. (8)

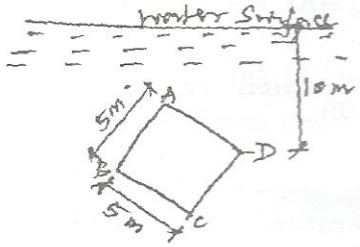

Fig. 3

Or

(b) (i) A vertical sluice gate 4 meters wide and 2 m deep is hinged at the top. A liquid of specific gravity 1.5 stands on the upstream side of the gate up to a height of 3.5 metres above the top edge of the gate and water on the down stream side upto the top edge of the gate. Find the resultant pressure acting on the gate and the point at which the resultant pressure acts. (8)

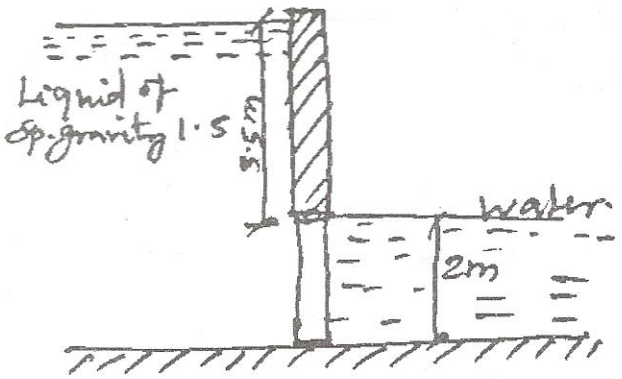

Fig. 4

(ii) A two dimensional flow is described by the velocity components, $u=5x^3$ and $v=-15x^2y$. Determine the stream function, velocity and acceleration at point $P(x=1m; y=2m)$. (8)

13. (a) Derive Euler's equation of motion for a steady flow of an ideal fluid along a stream line. (16)

Or

(b) (i) A fuel oil is pumped in a 300 mm diameter and 1.6 kilometre long pipeline at the rate of 100 lit/sec. The pipe is laid at an upgrade of 1:100. The specific weight of the fuel oil is $9kN/m^3$ and its kinematic viscosity is 21.4 stokes. Find the power required to pump the oil. (10)

(ii) What is meant by Impulse-Momentum Equation and what are the applications of Impulse-Momentum Equation? (6)

14. (a) A plate of length 750 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 5 m/sec. If the oil has a sp. gravity of 0.8 and kinematic viscosity of 1 stoke , Calculate

(i) Boundary layer thickness at the middle of the plate

(ii) Shear stress at the middle of the plate and

(iii) Friction drag on one side of the plate. (16)

Or

(b) Two pipes of diameter 400 mm and 200 mm are each 300 m long. When the pipes are connected in series the discharge through the pipeline is $0.10 m^3/\text{sec}$, find the loss of head incurred. What would be the loss of head in the system to pass the same total discharge when the pipes are connected in parallel. Take friction factor = 0.0075 for each pipe. (16)

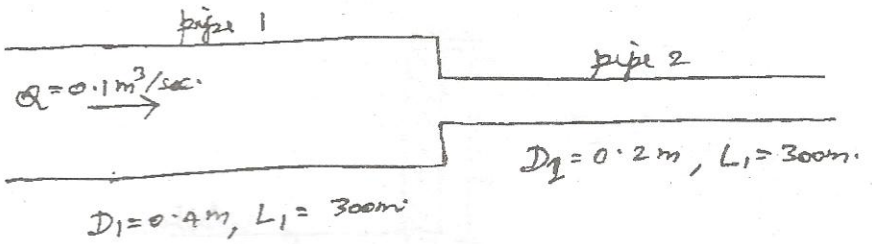

Fig. 5

15. (a) (i) State and explain in detail about Buckingham's π-theorem. (8)

(ii) Check the dimensional homogeneity of the following common equations in the field of hydraulics

(1) $Q = Cd.a.\sqrt{2gH}$ and

(2) $v = C\sqrt{m.i}$. (8)

Or

(b) (i) What is a distorted model? How does it differ from an undistorted model? Mention the advantages and disadvantages of distorted models. (8)

(ii) A spill way model built up to a scale of 1/10 is discharging water with a velocity of 1 m/sec, under a head of 100 mm. Find the velocity of water of the proto type, if the head of water over the prototype is 5.5 meters. (8)